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OFFICE OF EXPERIMENT STATIONS—BULLETIN 211.

A. C. TRUE, Director.

# IRRIGATION IN KANSAS.

BY

DON H. BARK.

PREPARED UNDER THE DIRECTION OF

SAMUEL FORTIER,

*Chief of Irrigation Investigations.*




WASHINGTON:

GOVERNMENT PRINTING OFFICE.

1909.

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607016

# LETTER OF TRANSMITTAL.

U. S. Department of Agriculture,
Office of Experiment Stations,
*Washington, D. C., February 15, 1909.*

Sir: I have the honor to transmit herewith a report on irrigation in Kansas, prepared by Don H. Bark, of this Office, under the direction of Samuel Fortier, chief of irrigation investigations. This is one of the series of reports prepared for the purpose of supplying information as to the opportunities for settlement in irrigated sections and as to the conditions to be met by settlers in taking up arid lands. It is recommended that it be published as a bulletin of this Office.

Respectfully,

A. C. True, *Director.*

Hon. James Wilson,
*Secretary of Agriculture.*

# CONTENTS.


| | Page. |
|---|---|
| Introduction | 7 |
| Water resources | 8 |
| Lands | 11 |
| Products on irrigated land | 12 |
| History of irrigation development | 13 |
| Irrigation enterprises | 15 |
| Irrigation from the Arkansas River | 15 |
| Frontier Ditch | 15 |
| South Side Ditch | 15 |
| The Western Kansas Flood Water Ditch | 16 |
| The Alamo Irrigating Canal | 16 |
| Fort Aubrey Irrigation Canal | 16 |
| Amazon Canal | 16 |
| South Side Canal | 16 |
| Great Eastern Canal | 17 |
| Finney County Water Users' Association, or Farmers' Ditch | 17 |
| Garden City Canal | 18 |
| The Eureka Canal | 19 |
| Lake Koehn Navigation, Reservoir, and Irrigation Company Canal | 19 |
| Private pumping plants | 19 |
| Irrigation from the Cimarron River | 21 |
| Clearmont Irrigation Canal | 21 |
| Settlers' Milling Canal and Reservoir Company | 21 |
| Hallack Ditch | 22 |
| Herring Canal | 22 |
| Irrigation from the South Fork of the Republican River | 22 |
| Jaqua Ditch | 22 |
| Benkleman Canal | 23 |
| Graves-Buck Ditch | 23 |
| Graves-Mitchell Ditch | 23 |
| Campbell Ditch | 23 |
| Smith-Buck Ditch | 23 |
| Ramsey Ditch | 23 |
| Laws governing the control and use of water | 24 |
| Settlement of irrigated lands | 25 |
| Future development of irrigation farming in Kansas | 27 |

# ILLUSTRATIONS.


| | | Page. |
|---|---|---|
| PLATE I. | Map of western Kansas, showing streams available for irrigation.... | 8 |
| II. | Map showing irrigation canals in the Garden City district..... | 16 |

# IRRIGATION IN KANSAS.

## INTRODUCTION.

The State of Kansas lies between the thirty-seventh and fortieth degrees of latitude and the ninety-fourth and one hundred and second degrees of longitude. It is 400 miles in length east and west and 208 miles north and south. The exact geographical center of the United States lies near Fort Riley, Geary County, in the east-central part of the State.

The surface of the State may be said to be one vast undulating plain which slopes gently toward the southeast. The altitude varies from 1,000 feet in the eastern to 4,400 feet in the northwestern part of the State.

There is a comparatively small amount of timber, and that is along the streams in the eastern part. Kansas has large and varied natural resources, but her principal wealth lies in her agriculture. It is the first State in the Union in the production of wheat, and ranks among the first in the production of corn. The other leading crops are hay, oats, buckwheat, barley, rye, flax, broom corn, alfalfa, sorghum, milo maize, Kafir corn, and sugar beets. The transportation facilities of the State are excellent.

The population of Kansas in 1905 was 1,554,968, but has materially increased since that time. The total assessed valuation of the State for 1908 was $2,453,691,859.

Kansas winters are usually mild, and the air is dry and bracing. The summers are warm, but the heat is not often oppressive. The mean annual precipitation in the eastern part of the State is 35.34 inches; that of Topeka is 34.25 inches; that of Wichita, with an altitude of 1,358 feet, is 30.34 inches. As one proceeds westward the altitude increases and the precipitation decreases until at Garden City, with an altitude of 2,830 feet, the mean annual rainfall is 21.87 inches. It is still less than this in some places along the western border of the State. According to the data of the Weather Bureau, in nearly all cases 80 per cent or more of the precipitation occurs from April to October inclusive, or during the growing season when the crops are most in need of it. This, however, is somewhat misleading, and while crop failures from drought in eastern Kansas are almost unknown, the rainfall of western Kansas is not at all times

sufficient to grow ordinary crops without an additional supply of moisture. Hence, irrigation must be resorted to in western Kansas. True, there have been "wet years," some of which were accountable for the boom days of the early eighties. These were in turn followed by a few dry years, which nearly depopulated the western portion of the State.

The following table gives the mean annual temperature, precipitation, and average dates of killing frosts in three typical localities as recorded by the United States Weather Bureau:

*Mean annual temperature, precipitation, and average dates of killing frosts.*

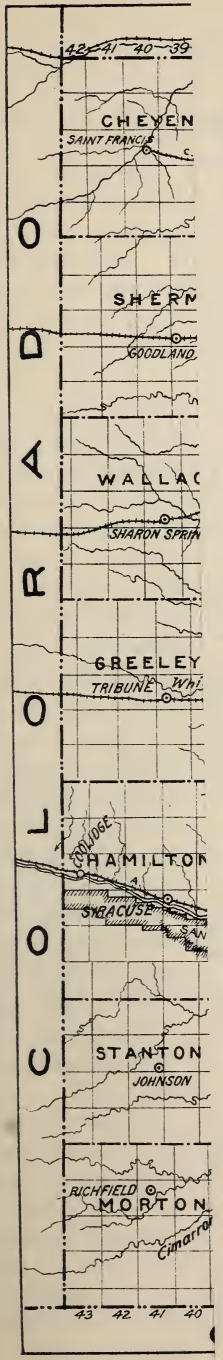
| Place. | Altitude. | Mean annual temperature. | Mean annual precipitation. | Average date of last killing frost in spring. | Average date of first killing frost in fall. |
|---|---|---|---|---|---|
| | *Feet.* | *° F.* | *Inches.* | | |
| Topeka | 890 | 54.0 | 34.25 | April 8 | October 13. |
| Wichita | 1,358 | 56.1 | 30.34 | April 6 | October 19. |
| Dodge City | 2,509 | 53.3 | 20.81 | April 17 | October 15. |

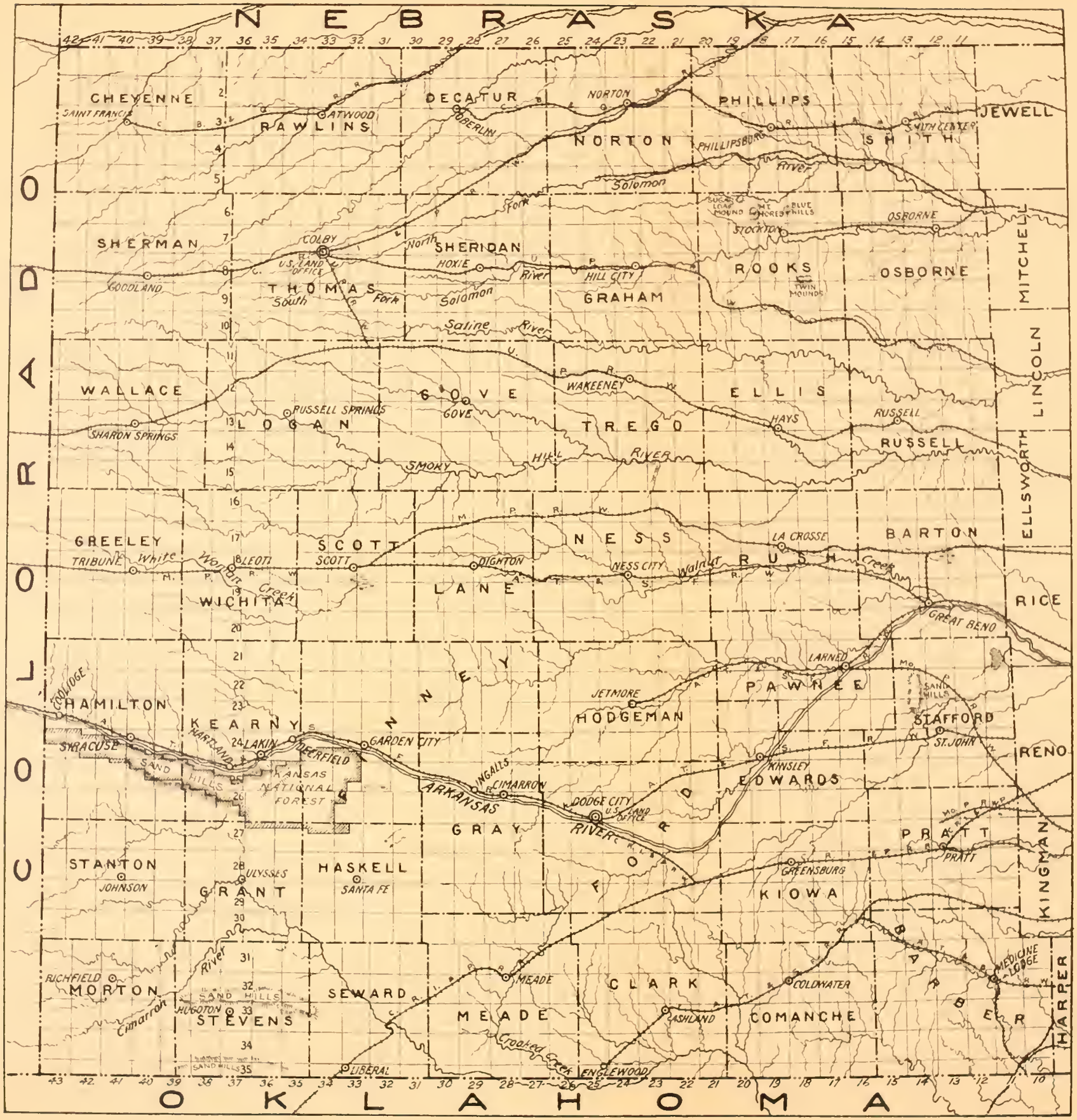
This shows an average growing season of six months or more, and that early and late frosts are not apt as a rule to injure ordinary crops.

Western Kansas has been settled up again, and a new and stable growth has begun. The settlers now understand conditions and the principle of dry-land farming—that is, the conservation of moisture. Irrigation ditches have been overhauled, new systems made, reservoirs built to catch the winter flood waters, and many pumping plants installed in the shallow-water districts along the upper Arkansas Valley. The people of this part of the State are now well able to cope with conditions as they find them, and each year will see more land cultivated and a greater crop production.

## WATER RESOURCES.

Kansas has been considered a well-watered State. Eastern Kansas has numerous streams which flow during the entire year, but in the western part, where rainfall is less, the need for irrigation is imperative. The wide, sandy-bottomed streams traverse a region of scanty rainfall, and much of the water is lost by seepage and evaporation. Large streams sometimes disappear in the sand. This is the case with White Woman Creek, which rises in the western part of the State and eastern Colorado, runs east through Greeley and Wichita counties, and is lost in the sand in Scott County (Pl. I). Streams of any size which rise in Colorado are drained, except during floods and high water, by the irrigators of that State before they reach the Kansas line. This means that the Kansas irrigator must construct


42
41
40
39
CHEYEN
SAINT FRANCIS
SHERM
GOODLAND
WALLAC
SHARON SPRIN
GREELEY
TRIBUNE
COLORADO
CHAMILTON
SYRACUSE
STANTON
JOHNSON
RICHFIELD
MORTON
43
42
41
40




MAP OF WESTERN KANSAS SHOWING STREAMS AVAILABLE FOR IRRIGATION.

ANDREW B. GRAHAM CO.

and use reservoirs to impound the water which comes down in the winter and thus retain it for irrigation during the summer season when the river is dry. The Cimarron River, which flows southeast through the southwestern part of the State, has always had some water for irrigation purposes. This is a broad, shallow stream similar to the Arkansas. As yet little water has been appropriated from this stream in Colorado, and at present the stream, as observed at a point south of Englewood, Clark County, flows during almost the entire year. There are now between 4,000 and 5,000 acres irrigated from this stream annually in Clark County, Kans., and Woodward and Beaver counties, Okla. With the present supply of water the area irrigated could be materially increased, no doubt doubled, by the practice of winter and early spring irrigation. The ground thus soaked would need much less water later when the supply in the river was diminished. The South Fork of the Republican River, which enters the State from Colorado and flows northeast through Cheyenne County, has water during all parts of the year for irrigation in Kansas. There are annually over 5,000 acres irrigated from this river in Cheyenne County alone, with ditches constructed and water enough to irrigate nearly as much more. The land under these ditches is held in large tracts, however, and comparatively little of it is under cultivation. This part of the State needs more settlers and smaller ranches in order to develop as it should. More and better results could be obtained with the present supply without the addition of a reservoir system by winter and early spring irrigation.

The three streams mentioned furnish practically all of the running water for irrigation purposes that can be utilized in western Kansas at present. Among some of the smaller streams that are used in a small way for irrigation might be mentioned Crooked Creek in Meade County and Smoky Hill River in Wallace and Logan counties.

In noting the water resources of western Kansas one should not overlook the enormous supply of underflow, or ground water, which is destined to play so important a part in the future development of that part of the State. This is easily available in different places and particularly in the upper Arkansas Valley from the Colorado State line as far east at least as Dodge City, a distance of over 100 miles. The origin of this underflow is not, as many people suppose, the real underflow from the Arkansas River which has disappeared from the river bed and is now flowing slowly along under the surface through the thick bed of sand which underlies all of this land, but it is made up of the precipitation which falls upon a large area both north and south of the river. The precipitation, minus that part lost by evaporation, is absorbed by the surface soil, which slowly but safely communicates it to the underlying strata of sand. It then begins its movement toward the lower level, which is generally in a

direction toward and with the current of the river itself. The depth of this flow from the surface varies with the elevation and the distance from the river, and generally speaking lies within 6 to 30 feet of the surface anywhere within the first or second bottom which skirts the river. The extent of this flow is not known, but it is believed by many to be practically inexhaustible. The depths to bed rock vary and are not exactly known, but it is safe to say that the sand and gravel underlying the whole valley are of depths varying from 30 to 300 feet and more in some places. This sand and gravel underlying the surface soil is filled with water from the bed rock up to within a few feet of the surface at all places within this shallow-water district. With this wonderful and seemingly inexhaustible supply of water so near the surface, it is not surprising that the people of this semiarid district should have resorted to pumping for irrigation purposes long ago.

Up to the present time neither the water plane nor the supply of ground water has been affected visibly by the individual pumping plants which are scattered throughout the shallow-water district, and it is the opinion of the writer that in the future, as these plants multiply and are finally established upon the majority of the farms in that district, but slight difficulty will be experienced from the lowering of the water plane. Systematic pumping should be advised, the water to be used locally, and in this way each plant would tend to replenish the underflow for the one next below. The effect of the steady pumping of large amounts from limited areas still remains to be seen, and may result in a partial or temporary depletion of the underflow from such area.

There are probably 100,000 acres along the upper Arkansas Valley that could be irrigated by pumping. Two other well-known underflow districts in the State, where similar pumping can and will be done in the near future, are the valley of the South Fork of the Republican River, in Cheyenne County, in the northwestern part of the State, and in the valley of the Cimarron in Clark County, Kans., and in Beaver and Woodward counties, Okla. There is probably 30,000 acres of good agricultural land in each of these valleys which could be irrigated by pumping from the underflow.

The artesian flow of western Kansas, while it has not yet proved strong enough to amount to much for irrigation purposes, should not be overlooked. About twenty wells in and near Coolidge, Hamilton County, are now flowing; some of these have flowed continuously for years, while others have been put down more recently. These wells are 200 to 350 feet deep and flow from 2 to 50 gallons per minute continuously. The largest artesian belt, however, in the western part of the State, lies in Meade County. There are several hundred wells in this county, many of which have been flowing for over ten years, and the quantity up to the present time has not decreased perceptibly. These wells vary in depth from 100 to 300 feet, the flow of the larger

ones being about 60 gallons per minute. None of these wells has been used to any extent for irrigation. The small flow would necessitate a reservoir, and the evaporation and seepage from this would in some cases about equal the flow from the well.

In summing up the question of the water supply of Kansas for irrigation purposes, it is to be strongly advised that reservoirs to catch and store the flood waters be constructed along the streams where irrigation is now practiced, and that more pumping plants be installed with which the underflow can be pumped for irrigation purposes.

## LANDS.

The area of Kansas is 82,144 square miles. It is twice as large as the State of Ohio or as large as Pennsylvania and Indiana combined. The water area is estimated as 384 square miles, leaving a land area of 81,760 square miles, or 52,326,400 acres, nearly all of which is arable. The soil ranges from a deep black loam in the eastern part to a more sandy soil farther west, but it is all very fertile.

There is some timber along the streams in the eastern part, but this gradually disappears as one travels westward, the western part of the State being almost devoid of timber. Timber has been planted in many portions of the State with success. Cottonwood, elm, locust, and catalpa are all recommended for western planting.

The Kansas National Forest, which was set aside in May, 1908, includes of 302,280 acres lying south of the Arkansas River in Finney, Kearny, Hamilton, and Grant counties. This land consists mostly of low-lying sand hills and had heretofore been considered waste land. The Forest Service proposes to plant the Government land within this area to forest trees. A nursery under irrigation is maintained at Garden City for the purpose of growing the young trees for the reserve. These trees consist mostly of black and honey locust, osage orange, cottonwood, and yellow pine, and the value of such an amount of timber to this section in a few years will be great.

There is no more free range in Kansas such as is found in the States lying farther west. The ground over which the cattle formerly ranged was nearly all homesteaded long ago, and where it is still unbroken and desired for pasture it may be leased of its present owners.

There is some land left in the western part of the State that can still be homesteaded. This is not the best land, and it is not irrigable. Under date of January, 1907, the United States Land Office put out the following official statement:

> There are about 700,000 acres in the Dodge City district which are still open for filing at this date. The desirable land in this district is located in Greeley, Hamilton, Stanton, Grant, Morton, Stevens, and Seward counties. This is all buffalo-grass upland; no bottom land can be secured. There is no timber. The crops raised most successfully are rye, wheat, barley, broom corn, Kafir corn * * * .

For the district covered by the land office at Colby, the report was as follows:

> There are some 50,000 acres of vacant lands in the district, of which Cheyenne County has 30,000. The remainder is scattered over the rest of the district, being mostly in 40-acre and 80-acre tracts.

A homestead entryman must be the head of a family or over 21 years of age and a citizen of the United States and not the owner of more than 160 acres of other land. A man who is under 21 years and married may take a homestead, but a single woman must be over 21 years.

The fee for a homestead is $18 for 160 acres of land if it is inside the railroad limits and $14 if it is outside. The railroad limit is a strip 10 miles wide on each side of the Santa Fe Railroad. The homestead law requires a settler to reside upon and cultivate his claim for a period of five years from date of entry. If the homesteader does not wish to remain five years on the land, he may prove up after fourteen months' continuous residence by paying $2.50 per acre if the land is inside and $1.25 per acre if it is outside of the railroad limits.

The irrigated land of Kansas is all confined to the western third of the State, and even there but a small percentage of the land cultivated is under irrigation. There are now 103,500 acres of land under ditch and it is divided as follows between the three principal valleys of western Kansas:

| | Acres. |
|---|---|
| Arkansas Valley | 83,500 |
| Republican Valley | 10,000 |
| Cimarron Valley | 10,000 |
| Total | 103,500 |

This land is now about one-half cultivated and could easily support many times the number of persons that now occupy it.

## PRODUCTS ON IRRIGATED LAND.

The crops grown under irrigation are alfalfa, sugar beets, wheat, oats, barley, rye, corn, cane, Kafir corn, sweet potatoes, and all sorts of orchard and garden crops. Alfalfa is the principal irrigated crop; it yields four to five crops per year, with an annual tonnage of 4 to 8 tons per acre. The alfalfa is generally fed locally to stock, although there are several large alfalfa-meal mills in the State which annually grind large amounts of hay into meal, which is shipped to the East where it commands a good price. Large acreages of alfalfa are raised in nearly every county of western Kansas, the greater part of the crop being raised without irrigation. On the so-called shallow-water land lying along the river bottoms, alfalfa does quite well without any

irrigation whatever. There are to-day large fields of alfalfa near Garden City in Finney County which were seeded twenty-four years ago upon land under which the sheet water lies at depths of 10 to 20 feet. These fields have never been irrigated nor reseeded and are producing two and three crops per year.

The sugar-beet industry has been tried successfully. There are annually about 12,000 acres of beets planted in western Kansas. These are all raised under irrigation and are either hauled direct or shipped by rail to the beet-sugar factory at Garden City, which is the only factory in the State at this time. The factory pays the grower $5 a ton for the beets delivered either at the factory or at the beet dumps, which are placed at each station along the railroad in the beet-growing districts. The beets produce 8 to 20 tons per acre and the profit to the farmer on a good crop is large. Profits of $20 to $50 an acre above all expenses are not uncommon. Beets can not be raised in western Kansas without irrigation.

Sweet potatoes require much care, but are raised with profit when the price is above 50 cents per bushel. The price here has ranged for the past three years above $1 per bushel.

All garden crops do well and produce large returns. Melons grow here to perfection and have been raised in the past for seed, the seed having been shipped in some instances by the carload. This was before the advent of the sugar factory.

Orchards produce very well. Peaches, pears, apples, cherries, and plums are all raised in the upper Arkansas Valley.

As water is not available for all of the land in the western part of the State, crops and varieties should be selected which are drought-resistant. Durum wheat, cane, Kafir corn, corn, broom corn, and alfalfa may be raised almost anywhere on the upland. With an average season fair crops can be raised if they are carefully cultivated to retain as much as possible of the moisture in the soil. Taking one year with another, the above crops will yield one-third to one-half as much as could be raised with an efficient system of irrigation. The above would pertain to only the western half or third of the State, as irrigation has not been considered necessary in other localities.

## HISTORY OF IRRIGATION DEVELOPMENT.

The first settlements in western Kansas of any note were made along the Arkansas River between the years 1870 and 1880. In the early part of the eighties, after the Santa Fe Railroad had been built, the boom days began. These were occasioned by the quick and easy mode the railroad afforded of entering this territory, which had hitherto been accessible only by team and wagon along the famous Santa Fe trail that skirts the Arkansas River, and also by the few

comparatively wet seasons which western Kansas had been enjoying at that time—1885. Large crops had been raised on the raw and newly broken buffalo-grass sod, with seemingly little effort. These two factors were largely accountable for the rapid increase in population at that time. Many improvements were made along all lines; farm lands and town lots sold at fabulous prices, ofttimes for more than they are worth to-day. It was at this time, while everything was on the boom, that most of the irrigation canals were started along the Arkansas River. The river at that time had a good flow during the entire year, except perhaps a few days during the summers of dry seasons. Canals to cover between 50,000 and 100,000 acres were constructed. These were scattered from Great Bend, Barton County, westward into Colorado. The greater part of the work was done in Finney and Kearny counties. These canals were never used at that time to their full capacities. Much of the land lying under them has never been broken and the original buffalo grass is still to be seen.

Those few moist and prosperous years were followed by dry ones. Very few of the people who had come into the country were then able to cope with conditions as they found them. They had brought eastern ideas and methods, and these methods, although successful under the different conditions of the East, would not work a like result in Kansas. The varieties of seed they had been planting for years in the East did not seem to yield well, nor would the eastern methods of culture bring results. As a consequence, many of the people left and went back to their former homes in the East, declaring that nothing could be done in an agricultural way in western Kansas. But there has been a marked change since those days. Many of the original settlers are still here; some of them were destitute and too poor to get away, while others remained because they had faith in the country. The greater percentage of these old settlers are to-day independent, but they have become so by adapting themselves and their methods of farming to the conditions. During the last ten years western Kansas has again filled up with settlers and homeseekers. This time it seems to be a stable growth. The people understand conditions and should succeed where their predecessors failed. Many improvements have been made and large amounts of land have been broken up for the first time.

The irrigation canals which were built years ago have been in some instances enlarged and remodeled, and nearly all of them are now in use. But during all this time a great development had been going on along the upper valley of the Arkansas River in Colorado. New ditches had been made and more water appropriated every year until the usual flow of the river is now diverted in Colorado

before the stream reaches Kansas. The result is that the ditches in Kansas are dry during a portion of the year when the irrigator needs the water. Some of the Kansas irrigators have constructed reservoirs and installed pumping plants in order to be assured of water for summer irrigation.

The company owning the beet-sugar factory at Garden City has constructed a reservoir that holds when full 30,000 acre-feet of water, or, in other words, enough to cover 30,000 acres 1 foot deep. This reservoir is filled during the winter when there is always a flow of water in the river, and the supply is used during the summer for irrigation. Private pumping plants have been installed in a great number of cases. The United States Reclamation Service has installed one at Deerfield which will irrigate 10,000 acres of land. This is the condition now in the Arkansas Valley. Everything seems to be on a settled basis, and the farmer who has a good pumping plant of ample capacity has no need to worry over the lack of rain or of water in the river.

Canals have been constructed in other places, notably in Cheyenne County, where the water is taken from the south fork of the Republican River, and in Clark County, where some water is taken from the Cimarron River. There are thousands of acres in western Kansas for which water is not available for irrigation purposes.

## IRRIGATION ENTERPRISES.

### IRRIGATION FROM THE ARKANSAS RIVER.

The following is a description of the ditches in Kansas which divert water from the Arkansas River, beginning at the Colorado State line and describing them in their order from thence eastward (Pl. II):

#### FRONTIER DITCH.

This ditch heads on the north side of the river 1.5 miles west of the Kansas State line in Colorado. It is 7 miles long, 8 feet wide on the bottom, and was constructed in 1895, and irrigates 3,000 to 4,000 acres. It is owned by five men, who own the land which lies under it. Maintenance charges are $1.50 per acre each year.

#### SOUTH SIDE DITCH.

This ditch diverts water from the south side of the river about 2.5 miles west of the western boundary of Kansas, and was built in 1884. It is 4 feet wide on the bottom and is supposed to carry enough water to irrigate 1,000 acres, but it will hardly do this in its present condition. This ditch is owned and operated by two individuals.

### THE WESTERN KANSAS FLOOD WATER DITCH.

This ditch is taken out of the south side of the river in section 32, township 23, range 42, in Hamilton County, and was completed during the summer of 1908. The company has filed on 50 cubic feet per second of water, which may be rather more than the ditch will carry. The ditch is 8 feet wide and will cover 3,500 acres of land when completed. It is owned by the farmers who have land under it.

### THE ALAMO IRRIGATING CANAL.

This ditch was constructed some years ago and will irrigate approximately 4,000 acres. The water is diverted on the north side of the river about 9 miles above Syracuse.

### FORT AUBREY IRRIGATION CANAL.

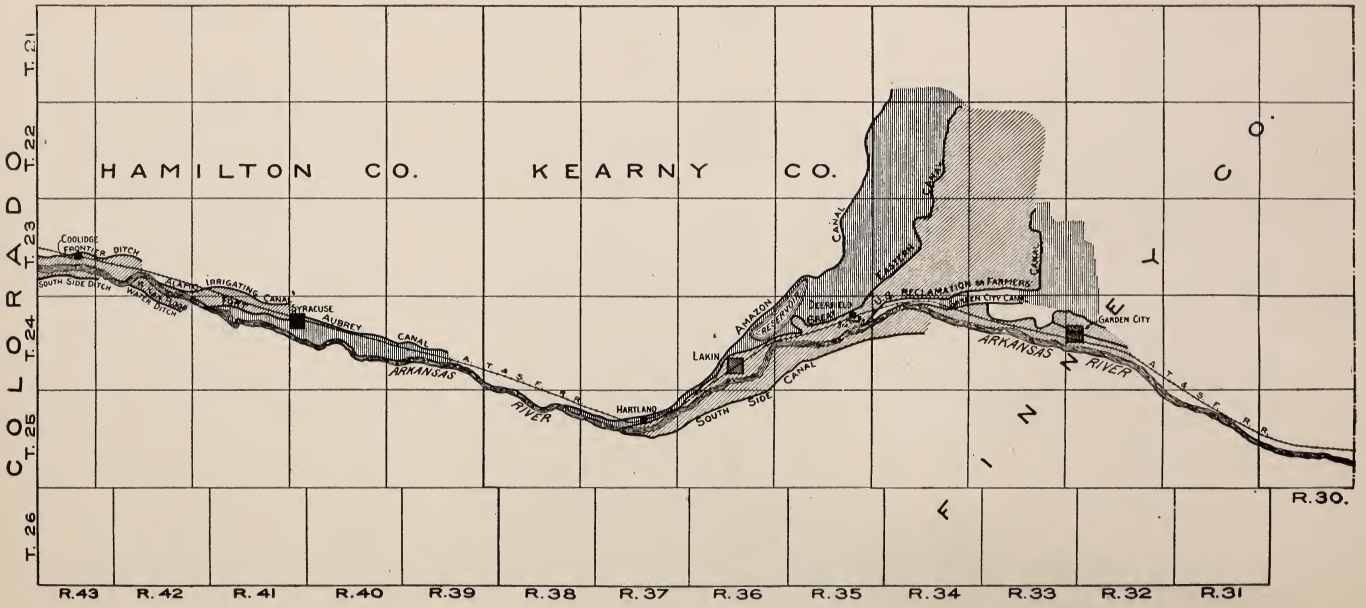
This canal is lateral No. 1 of the old Alamo Canal. It was bought by its present owners in April, 1903. The headgate is situated on the north side of the river about 4 miles above Syracuse. The canal is 20 feet wide on the bottom and 12 miles long and covers 10,000 acres of land, but this is not all under cultivation at present, much of it never having been broken up. Probably less than one-half of the land is irrigated each year. The canal is in fair condition, but requires some cleaning at various places along its length. It is owned by a private corporation composed of landowners under the ditch. The capital stock is $10,000, of which $5,000 is paid-up stock. The maintenance charges are $1.50 per acre each year.

### AMAZON CANAL.

This canal diverts water from the river a short distance above the town of Hartland. It was built during the years 1888–1890. It is 30 miles long and designed to carry approximately 190 cubic feet of water per second. There are 14,000 acres under this canal, of which possibly one-half is irrigated each year. The stock of this canal company consists of 150 shares, which are now selling at $800 each. At present 60 of these shares are controlled by the United States Sugar and Land Company and the remainder by individual owners under the ditch. The maintenance charges for the years 1907 and 1908 were 20 cents per acre per year.

### SOUTH SIDE CANAL.

This canal diverts water from the south side of the river almost directly opposite the headgate of the Great Eastern Canal which is on the north side of the river. It is owned by the United States Irrigation Company of Garden City. The canal is 20 miles long and covers between 12,000 and 13,000 acres of land. This land is not all irrigated




MAP SHOWING IRRIGATION CANALS IN THE GARDEN CITY DISTRICT.

U. S. Dept. of Agr., Bul. 211, Office Expt. Stations. Irrigation Investigations.

at present, but the United States Sugar Company is preparing to install a pumping plant which will furnish a constant supply of water for lands under this ditch. This plant will be located at Deerfield, where electricity will be generated and transmitted to the pump stations, of which there will be thirteen. The power will be a gas engine using gas made from fuel oil by a producer plant of 400 horsepower capacity. The stations are each designed to pump 4 cubic feet of water per second and will be located at more or less regular intervals over a space of 15 miles, where they will pump, not into the main ditch, but directly into the farm laterals. This plan of installation will overcome the large amount of seepage and evaporation which is unavoidable in the long line of ditch necessary where one large central plant is used. The plant is planned to be in operation by March 1, 1909.

### GREAT EASTERN CANAL.

This canal diverts water from the north side of the river near Hartland. It has a capacity for the first 3 miles of its length of 1,100 cubic feet per second, where it empties into a reservoir with a capacity of 30,000 acre-feet. The reservoir is filled during the winter, at which time there is usually a large supply of water in the river. The remainder of the canal which leads from the reservoir in a northeast direction is much smaller, having a capacity of 175 cubic feet per second. This canal and reservoir system is owned by the United States Irrigation Company. The stock is composed of 300 water rights of 10 acres each, the par value of which is $200 each. There are no stock or water rights for sale, however, under this ditch. The Sugar and Irrigation companies own enough land under this system to utilize all of the supply.

### FINNEY COUNTY WATER USERS' ASSOCIATION, OR FARMERS' DITCH.

This canal was built in 1884 by the farmers of Finney County. It diverts water from the north side of the Arkansas River about a mile below the town of Deerfield. The main canal is 16 miles long and about 15 feet wide on the bottom and covers 10,000 acres of land.

The United States Reclamation Service has completed a pumping plant which pumps from the underflow and fills this canal when there is no water in the river. This plant has been in operation since April 1, 1908. The plant consists of a central power station where electricity is generated by steam and transmitted to twenty-three pump stations located every 1,000 feet along a cement conduit, over 4 miles long, which delivers water to the canal about a mile below its headgate. The power station, housed by a substantial building of

brick, is located at Deerfield on a spur track from the main line of the Santa Fe Railroad. The plant proper consists of two 200-horsepower water-tube boilers, which generate steam at 150 pounds pressure, and two steam turbine-driven alternators, each machine having a capacity of 225 kilowatts, 6,600 volts, 60 cycles, 3-phase with an exciter direct-connected to the shaft of each of the generators. The current is transmitted on two separate circuits to the pump stations at a voltage of 6,600. There it is transformed from 6,600 to 220 volts by means of three 8-kilowatt transformers. Each pump station consists of a 25-horsepower, 3-phase, 220-volt, 60-cycle, induction motor, direct-connected to a No. 10 vertical double upper-suction centrifugal pump. Each pump is connected by suction pipe to nine or twelve wells. These wells are 15 inches in diameter and vary from 30 to 60 feet in depth, all of them having been put down to clay. It is proposed to run this plant six months each season, from April to September, inclusive, except at such times as there is water in the river in sufficient quantities to use for irrigation. The plant will irrigate 10,000 acres, covering the land with water 2 feet deep during the season. The cost of the plant is $350,000, or $35 per acre, which is to be paid by the owners of this 10,000 acres in ten equal annual installments of $3.50 per acre each, without interest. The water users are also subject to the maintenance charges, which are to be paid each year. The expense for the season of 1908 is estimated at $27,500, which will be $2.75 per acre. This plant, though having been in operation but one season, has given good satisfaction.

### GARDEN CITY CANAL.

This canal diverts water from the north side of the river about 10 miles above Garden City. It was constructed during the early eighties, but has changed hands and has been enlarged and remodeled several times. It is now owned by a company of farmers. The stock consists of 600 shares of 10 acres each, the par value of which is $25. These shares are now selling for $75 each, and there is a strong probability of raising them to $100 per share. The main canal is 10 miles long and is supposed to carry between 80 and 100 cubic feet per second of water and irrigate 10,000 acres. The town of Garden City lies at the lower end of the tract irrigated by this canal. There is a large number of private pumping plants in operation under this canal.

There are no other canals at present in use below this one along the Arkansas River. Two others were constructed several years ago, but have long since been abandoned for various causes, the principal one of which was the uncertainty of water supply that far down the river. As the above-mentioned canals, together with numerous others in Colorado, all divert water above them, it can be readily

seen that the supply for these would be small indeed. The diversion of water in Colorado has made the supply for all of these ditches above mentioned, which lie in Kansas, very uncertain. The amount is not proportioned between Kansas and Colorado, but the Kansas irrigator gets only as much of the stream flow as the Colorado irrigators do not use. The river flow at the various places of diversion of these different canals in Kansas varies from 40 to 200 days per year, the canals heading farther up the river securing the larger flow.

The two ditches which have been abandoned are the Eureka Canal, commonly known as the Soul Ditch, and a canal near Great Bend, constructed in the latter part of the nineties by the Lake Koehn Navigation, Reservoir, and Irrigation Company.

### THE EUREKA CANAL.

This canal originally diverted water from the river near Ingalls and conveyed it eastward for a distance of nearly 50 miles and was supposed to irrigate between 30,000 and 50,000 acres. This ditch was owned by a foreign corporation, which long ago abandoned it on account of litigation and lack of water. This ditch probably cost nearly a million dollars when originally constructed, and it is very doubtful that anything will ever be done with it.

### LAKE KOEHN NAVIGATION, RESERVOIR, AND IRRIGATION COMPANY CANAL.

This canal, as planned and constructed, was to divert water from the river about 6 miles southwest of Great Bend and convey it through a ditch 14 miles long in a northeasterly direction, to where the water was to be stored in a natural reservoir locally known as the Cheyenne Bottoms. This reservoir itself would have covered more than 25,000 acres of land with water. The canal was completed in 1900, but the supply of water being small and the company having become involved in litigation, the project was abandoned and has never been in operation. The title to the lands condemned has reverted to the original owners and it is not probable that the system will ever be used.

### PRIVATE PUMPING PLANTS.

Private pumping plants have been installed on some farms under these ditches and elsewhere to supplement the flow from the river. The farmers of the Arkansas Valley are fortunate in having a practically inexhaustible supply of water comparatively near the surface. These pumping plants at present consist chiefly of gasoline engines and centrifugal pumps, pumping from one or more wells. The water is found in depths ranging from 6 to 20 feet throughout the district. The gasoline plants vary in size from a 2-horsepower engine with a

pumping jack and plunger pump and one well up to 20-horsepower engines with No. 6 centrifugal pumps and three or more wells. The large sizes, such as the one mentioned, will pump 1,000 gallons of water per minute with a total lift of about 20 feet and will irrigate about 100 to 120 acres. Such a plant completely installed will cost at the present prices from $1,200 to $1,500, varying with local conditions and with the make of plant installed, or about $12.50 per acre. The cost per acre would be somewhat higher with smaller plants. The cost of irrigating 1 acre depends first upon the price of fuel, second on the height of the lift, and third on the efficiency of the plant and also upon the depth of water applied to the soil. A large number of tests under ordinary conditions showed the cost of irrigating an acre to vary from 30 cents to $1.50. These tests were made at Garden City. The price of gasoline was 11.5 to 15 cents per gallon, the total lift of water 15 to 30 feet. The cost for gasoline and lubricating oil per acre-foot was found to range between $1.35 and $3.15. The latter is too high, caused by the inefficiency of the plant tested.

A considerable area in this shallow-water district is irrigated by windmills and small reservoirs. Sometimes there are two or more windmills pumping directly into one reservoir. Windmills of the ordinary types are used, with shallow-water pumps of a special type. These pumps have large brass-lined cylinders sometimes 10 or 12 inches in diameter and strokes of 8 to 18 inches, and lift from 2 to 6 gallons at each stroke. With a favorable wind, such a pump will pump a large amount of water in a day. It is always advisable to have a reservoir in connection with a windmill plant. This can be cheaply constructed with earthen banks by the farmer. The bottom of the reservoir should always be well puddled to prevent seepage. By the use of the reservoir a large amount of water can be stored and when needed for irrigation a large volume can be used during a short time, thereby saving time and accomplishing much more than by using the flow direct from the pump. Two 12-foot mills with 18-inch stroke and pumps whose cylinders are 10 inches in diameter and a reservoir 50 to 75 feet square holding 3 feet of water will serve from 5 to 8 acres. The reservoir should not be too large, as the seepage and evaporation is less from a smaller one. If the farmer builds his own reservoir the cost for mills, pumps, and wells complete, at local prices, is about $330 for two 12-foot mills, as follows:

| | |
|---|---|
| Two 12-foot mills, 25-foot tower, each $75 | $150 |
| Two 10-inch pumps, each $40 | 80 |
| Two 16-inch wells, 30 feet deep, each $50 | 100 |

The principal crops which are raised in the Arkansas Valley under irrigation are alfalfa, sugar beets, wheat, Kafir corn, sugar cane, melons, Irish and sweet potatoes, orchard products, and garden vegetables of all kinds.

## IRRIGATION FROM THE CIMARRON RIVER.

The Cimarron River enters Kansas from the west about 6 miles north of the southwest corner of the State in Morton County, and flows northeast through Stevens County, touching Grant County. Here it changes its course to southeast through Seward and Meade counties, where it leaves the State and enters Oklahoma. It flows east for 30 miles just south of the north boundary of Oklahoma, when it enters Kansas again near the center of the south line of Clark County.

The greater part of the irrigation from the Cimarron River is near Englewood, Clark County, Kans. There are no official measurements or ratings which can be depended upon to show the average annual flow of the stream, but it has been sufficient to irrigate 4,000 to 5,000 acres every year since the ditches were built, over ten years ago. There are now four ditches which divert water from the river south of the town of Englewood, the river being in Oklahoma at that point.

### CLEARMONT IRRIGATION CANAL.

This canal leaves the north side of the river about 5 miles south and 2 miles west of the town of Englewood. It was constructed several years ago by Col. C. D. Perry, and originally covered 1,000 acres of land, but it is now in poor condition and needs cleaning, and will not carry more than enough water to irrigate 500 acres of land. This is the only ditch in that section that waters land in Kansas from the Cimarron River.

The three ditches which take water from the river on the south side, although irrigating land in Oklahoma, will be described here, as the produce from these farms and lands irrigated by them must be hauled to Englewood, which is in Kansas, and is the only railroad point for that immediate section.

### SETTLERS' MILLING CANAL AND RESERVOIR COMPANY.

This canal diverts water from the river about $2\frac{1}{2}$ miles above the headgate of the Clearmont Canal, but on the south side of the river. It runs east and covers about 7,000 acres of land, of which there are at present between 3,000 and 4,000 acres irrigated each year. This canal has a bottom width of 14 feet at the headgate and its total length is 15 miles. It has recently been repaired and cleaned, the entire ditch now being in a very good condition. The canal is owned by eight men, who own all of the land under it.

HALLACK DITCH.

This canal diverts water from the river below the Settlers' Canal, and the land it waters all lies under the above-named canal. It is in poor condition at present and needs cleaning. It is supposed to carry enough water to irrigate between 800 and 1,000 acres and belongs to the Hallack ranch.

HERRING CANAL.

This canal diverts water from the south side of the river below the other ditches. It is 4 feet wide on the bottom and 7 miles long. It was constructed and is owned entirely by one individual. There are at present about 500 acres irrigated from it each year. By extending and enlarging this canal it could be made to cover 4,000 or 5,000 acres of land.

This describes all of the irrigation of any note in Kansas and in adjacent parts of Oklahoma from the Cimarron River. There are nearly 30,000 acres of land lying tributary to Englewood, which will probably be under cultivation at no distant date. The available river flow can be helped out by pumping from the underflow, which has been thoroughly tested in that locality and found to be sufficient for pumping purposes. The principal crop raised under irrigation is alfalfa, which is all fed locally. Other crops are corn, Kafir corn, broom corn, sorghum, wheat, oats, rye, and barley. All these do well here

## IRRIGATION FROM THE SOUTH FORK OF THE REPUBLICAN RIVER.

The South Fork of the Republican River rises in Colorado and flows northeast diagonally through Cheyenne County, Kans., emptying into the main stream of the Republican River, a few miles north of the State line, in Nebraska. The flow of this river has never been officially measured or rated, but it has always furnished a comparatively large amount for irrigation in Kansas. There are now eight irrigation ditches in use in the county, as follows, naming them in order along the river, from the south to the north:

JAQUA DITCH.

This ditch diverts water from the south side of the river, a few miles west of the State line in Colorado, and conveys it in a northeasterly direction into Cheyenne County, Kans. This ditch was constructed years ago by a number of outside capitalists, who became involved in litigation and eventually abandoned the canal entirely, thereby losing title to the same. The ditch was originally about 25 miles long and covered 25,000 acres. In 1894 a number of farmers owning land under the ditch remodeled and cleaned the upper part of it and have

since gained title to that part of it. There are now about 7 miles of it in operation in the State of Kansas which covers 3,000 acres of land, of which about 1,200 is in cultivation and irrigated each year.

BENKLEMAN CANAL.

This ditch is owned and operated by a number of farmers. It was constructed in the early nineties, has been in operation continuously since, and covers 2,000 acres on the south side of the river, of which about 800 are annually irrigated.

GRAVES-BUCK DITCH.

This ditch was constructed in 1898 by Messrs. Graves and Buck and could be made to irrigate 800 acres on the north side of the river. About 400 to 500 acres are irrigated annually from it.

GRAVES-MITCHELL DITCH.

This ditch is in operation at present and irrigates 450 acres each year out of a possible 700 acres. This is a private ditch, similar to the others in that section, and is owned by Messrs. Graves and Mitchell.

CAMPBELL DITCH.

This is one of the smallest ditches in the county and is owned by the Campbell ranch. The ditch covers 200 acres of good irrigable land, but an 80-acre farm is all that is irrigated from it at present.

SMITH-BUCK DITCH.

This ditch was constructed by Messrs. Smith and Buck in 1891. It is approximately 5 miles long and irrigates 1,000 acres annually out of a possible 1,500 acres.

RAMSEY DITCH.

This ditch was constructed in 1895. It is 3½ miles long and there are about 200 acres irrigated from it each year. The ditch covers 800 acres of bottom land.

Messrs. Charles Richardson and Kenneth McDonald have each nearly completed a ditch which will irrigate about 500 acres. This completes the list of irrigation ditches in Cheyenne County. It can be seen by summing up that there are 10,000 acres under ditch in the county, of which less than one-half is irrigated and cultivated. This locality has not suffered from lack of water as much in the past as have some other localities, but without storage or extensive winter irrigation being practiced there will probably not be sufficient water

at all times to irrigate all of the land which is now under ditch. However, the indications seem to be strong that the valley is favored with a good underflow, such as is being pumped successfully for irrigation in other places, and should the river flow become insufficient as more of the land is put under cultivation there is no doubt that pumping can be done successfully. It is estimated that there is 44,000 acres of good bottom land in Cheyenne County alone. There are strong indications that a beet-sugar factory will be established at St. Francis in the near future.

The principal crop raised in the valley under irrigation is alfalfa. This is generally fed to cattle, of which there are large numbers in that vicinity. Alfalfa makes a total yield of 3 to 6 tons per acre. Among other field crops are corn, wheat, oats, rye, barley, cane, Kafir corn, and potatoes.

## LAWS GOVERNING THE CONTROL AND USE OF WATER.

The following is an abstract from the general statutes of Kansas of 1901 on the appropriation of water:

Any person, company, or corporation desiring hereafter to appropriate water must post a notice in writing at a conspicuous place at the point of diversion, stating therein, first, that such person, company, or corporation claims the water flowing to the extent of —— inches, measured under a 4-inch pressure, and describing and defining as accurately as may be the point of diversion: second, the means by which such person, company, or corporation intends to divert it and the size of the canal, ditch, flume, or aqueduct in which he intends to divert it. A copy of such notice must, within ten days after it is posted at the place of diversion, be also posted in a conspicuous place in the office of the county clerk of the county in which such place of diversion is situated and be recorded by the county clerk in a book kept for that purpose.

Within sixty days after the notice is posted the claimant must commence excavation or construction of the works in which such claimant intends to divert the water and must prosecute the work diligently and uninterruptedly to completion unless interrupted by stress of weather. By completion is meant conducting water to the place of its intended use. By a compliance with the above rules the claimant's right to the use of water relates back to the time notice was posted. A failure to comply with such rules shall deprive the claimant of the right to the use of the water as against a subsequent claimant who complies therewith.

The fact that less than one five-hundredth of the agricultural land of Kansas is irrigated probably explains the limited scope of the Kansas irrigation law, in comparison with that of some of the other more arid States where all agriculture depends upon irrigation, and hence upon the protection of the irrigator and upon the just and equitable distribution of the water. In nearly all of the western irrigated States the office of State engineer is provided for and it is his duty to supervise the acquirement of water rights and distribute water to water-right holders. A State is sometimes divided into districts, in each of which a water commissioner is appointed to see that each irrigator

receives his just share of the water. These commissioners are responsible to the State engineer for the enforcement of the irrigation law in their districts. Such a system might be inaugurated in western Kansas with good results, but it is doubtful if there is sufficient water supply or irrigated area to warrant such an elaborate and complete system of supervision.

## SETTLEMENT OF IRRIGATED LANDS.

As the labor and expense of establishing a home in a new locality and the putting of a new farm into crop is generally one of the first things thought of and one of the first questions asked by a person contemplating a change in locality, it is well to give here an outline of what would be needed and of the probable cost of the same at current prices. In connection with this it should be remembered that these prices are likely to vary slightly in different towns and localities. Much depends upon the taste, ability, and energy of the settler as to what and how much he finds necessary. The first item to be considered would be the farm itself and the water right. Land and water together can be bought in any one of the three principal irrigated sections, namely, along the Arkansas in Hamilton, Kearny, and Finney counties; along the Cimarron in Clark County, Kans., and Woodward and Beaver counties, Okla.; and in the valley of the South Fork of the Republican River in Cheyenne County, at prices varying from $25 to $100 per acre. These prices vary with distance from town and other factors, but the above amounts are considered the average prices.

About the only factor in the preparation of the land for an irrigated crop that is subject to any great variation is the first leveling of the land. While the farms of western Kansas lie very well for irrigation and need but little leveling in comparison with some lands in other irrigated districts, it will always be well to spend time and money enough in the first leveling to do it thoroughly, as the leveling being once done is done for all time. The extra cost is saved many times over in the saving of both time and water while irrigating. A well-leveled field can be irrigated with one-half or one-third the labor necessary to irrigate one that has been carelessly leveled. It is not necessary to make the slope a gradual, even one from one side of the field to the other, but the hollows should be filled and the high places leveled down so that the water will run uninterruptedly from one ditch to the next one below it. Hence it can readily be seen that the cost for leveling will not be the same on any two farms. It can safely be stated that the cost will average from 50 cents to $5 per acre over the greater part of western Kansas, as against $2 to $20 per acre in parts of Wyoming, Idaho, Colorado, and some other States.

The following are the average prices of contract work, such as are asked in the vicinity of Lakin and Garden City, allowing a man and team $4 per day:

| | Per acre. |
|---|---|
| Plowing raw sod | $2.00 |
| Double disking | 1.00 |
| Leveling (depending on lay of land) | 1.00–$5.00 |
| Harrowing four times | 1.00 |
| 15 pounds alfalfa seed, at 15 cents | 2.25 |
| Drilling same | .50 |
| Constructing ditches | .50– 1.00 |
| Irrigating three times | 1.50 |
| Total | 9.75–14.25 |

This amount of work should put ordinary land in good shape and secure a good stand of alfalfa, which could possibly be cut twice the first season and thereby be made to pay the cost of the preparation of the ground. The above amount of labor could be done much cheaper by the farmer himself by using his own teams and implements. Three good horses weighing from 1,200 to 1,400 pounds each should be able to do the work on 40 to 60 acres of land and will cost from $75 to $150 each. The merchants keep in stock goods of all kinds which can be bought at practically the same prices as are asked in the East with the extra freight added. Lumber, building material, and posts can be bought of any grade or in any quantity. The following are the average 1908 prices:

| | |
|---|---|
| Rough lumber, suitable for barns, cheap houses, and outbuildings, per M | $26.00–$30.00 |
| Shingles, best cedar, per M | 4.00 |
| Fence posts, cedar, each | .15– .20 |
| Portland cement, per cwt | .50 |

The funds actually necessary to establish a home and start farming successfully, as mentioned before, vary with the individual, but the following may be considered averages, using an 80-acre farm at a cost of $40 per acre as a basis:

| | |
|---|---|
| 10 per cent of $3,200, first payment on 80 acres | $320 |
| Four average horses, at $90 each | 360 |
| Implements, harness, wagons, etc | 600 |
| Lumber for house, small barn, fences, etc | 500 |
| Horse feed, seed, etc | 500 |
| Total | 2,280 |

Many have started with less than one-half of this and have been very successful. By bringing one's own goods, farm tools, and horses from the East one could start much more cheaply. There is plenty of room and plenty of land left in western Kansas to make homes for thousands. There are large tracts of land that have never yet been cultivated which can be bought at very reasonable prices. This is not all irrigable land, water for a comparatively small part of it being

available. The unirrigated land will raise a crop nearly every year if it is tended properly, but even during the so-called "good years" the crop will not compare in quality or yield with that from an irrigated farm.

Kansas is well supplied with good schools and churches of all denominations. The present settlers are of an excellent class, being mostly native-born Americans, and any deserving new settler, no matter where he may be from, is cordially welcomed.

## FUTURE DEVELOPMENT IN IRRIGATION FARMING IN KANSAS.

Notwithstanding the scarcity of water for irrigation in western Kansas, there is yet much chance for development along many lines. Something must be done to catch the flood waters of the rivers during the late fall, winter, and early spring. Large reservoirs could and should be built with capacities sufficient to hold the entire flow of the rivers. This would be rather expensive, as there are no good natural sites available where the water could be impounded as cheaply as in some localities closer to the foothills. Lake McKinney, or reservoir No. 5 of the United States Sugar and Land Company, is a good example of what can be done in this line. There are large areas of land which could be irrigated by the construction of reservoirs at the lower ends of small dry runs which carry off the flood waters from large areas. In many instances water enough to irrigate from 10 to 100 acres could be caught from one such stream and held in the reservoir until needed for irrigation. This would afford a good and efficient irrigation system for a farm of sufficient size to support a family. There are numerous streams where such a system could be installed in western Kansas.

The area in Kansas in which pumping plants could be installed and operated profitably is of considerable size. This method of irrigation is but in its infancy and the indication is that its use will rapidly increase in the future. There is not a pumping plant at present in the Cimarron Valley, but there are at least 20,000 acres that could be so irrigated. Cheyenne County has also large areas that no doubt could be irrigated in the same way. Various companies are now putting out gas-producer plants, which, in connection with a gas engine, will make a much cheaper power than gasoline or electricity for pumping purposes. There is no doubt that the future will see many of these in operation in Kansas for pumping purposes.

Windmills are no small factor in the irrigation of the western part of the State. Throughout large areas the water is so near the surface that a windmill will operate a pump with an 8, 10, or 12 inch cylinder and a stroke of equal length, and it is surprising how much one windmill and pump will irrigate. On the dry, upland farms of the West, where cattle raising is the chief industry and trees and garden are uncertain without water, a good well and windmill will irrigate a small garden and keep numerous shade trees growing even in the driest

seasons. This not only assures the farmer potatoes and vegetables enough to last during the winter, but will keep alive the shade trees and grass which make the home so much more cheerful.

The greatest improvement, however, that could be made would be to introduce new modes of irrigation and to teach the Kansas irrigator to use irrigation water more economically and efficiently. This could be done in several ways. All land is invariably flooded, which is wasteful as compared with the corrugation method. The ditches are too far apart, which means an oversaturation of the ground near the feed ditch before the water can be forced to the other end of the run. Runs of 200 to 500 feet are preferable to those of 40 and 80 rods, now commonly used. More thorough cultivation should be practiced. Such cultivation loosens the surface soil and forms a dust mulch which retains the moisture and keeps it for the use of crops. More good could be secured from the same amount of water by using larger heads for shorter periods; that is, if two farmers on adjoining farms could agree to each use on alternate days or weeks the whole flow allowed to both, instead of dividing the stream between them and each receiving a smaller but continuous flow, more could be accomplished with the same amount of water and with less labor.

Too much stress can not be laid on winter irrigation. Where the flow from the river is depended upon, winter irrigation should be practiced whenever and wherever possible and practicable. Ditches should be kept clean and in order so that the river flow can be utilized whenever it comes. It seems folly to let the water flow past in the river all the fall, winter, and early spring because it is not needed at that time for growing crops. The water should be turned upon the fields during this time and the entire farm should be flooded. Then, by disking the surface in the spring and retaining as much as possible of this moisture, fair crops would be assured whether or not summer irrigation is possible.

It is a familiar scene in eastern Kansas and, in fact, throughout all of the districts devoted to agriculture in the United States, to see crops suffering from lack of moisture during some season of the year. This lack of moisture is ofttimes at a critical period during the plant's growth, when one irrigation would mean the difference between failure and a large crop. Gardens lying along streams could be irrigated at such times, assuring a maximum production during the driest seasons, when high prices prevail.

The following are a few localities in Kansas where such systems might be advisable: Along the lower Arkansas from Hutchinson to Arkansas City, in Reno, Sedgwick, Sumner, and Cowley counties; along the Little Arkansas, which empties into the Arkansas at Wichita; along the Solomon, Saline, and Smoky Hill rivers, in east central Kansas; and from the Kansas River near Topeka.